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ABSTRACT

The purpose of this study was to test the applicability of the dual coding hypothesis to children's recall performance. The hypothesis predicts that visual interference will have a small effect on the recall of visually presented words or pictures, but that acoustic interference will cause a decline in recall of visually presented words and pictures, with the recall of words being worse than that of pictures. In addition, the degree of recall by interference task was predicted to be reversed from short term to long term memory within presentation types. Nouns were presented to 30 third grade children in picture, printed word or spoken word form and followed by visual, acoustic, simultaneous, or no interference. Recall of the items and of presentation type was elicited after each triad. After all triads were presented, children were asked to free-recall as many items as possible and to indicate presentation type as a measure of long term memory. Evidence of differential storage of printed words versus spoken words was detected in short term memory. All data showed superior recall for pictures. These results were generally consistent with Paivio's dual coding hypothesis and with findings of adult studies. However, the expected reversals from short term memory to long term memory were supported by the data only to a minimal degree and only at intermediate levels of interference. (Author/SS)

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ABSTRACT

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Nouns were presented to children in picture, printed word or spoken word form and followed by visual, acoustic, simultaneous, or no interference. Recall of the items and of presentation type was elicited after each triad. Participants free-recalled as many items as possible and indicated presentation type as measures of long-term memory after all triads were presented. Evidence for differential storage of printed words versus spoken words was detected in short-term memory. All data showed superior recall for pictures. These results were related to Paivio's dual coding hypothesis and to recent research by Pellegrino et. al. (1975, 1976a, 1976b).

Dual Coding in Children

Recent research with adult subjects by Pellegrino, Siegel, and Dhawan (1974, 1976a, 1976b), has focused on the effects of acoustic interference and visual interference on the recall of pictures and words. In their work Paivio's two systems imaginal and verbal have been operationalized as visual and acoustic systems. Traids of picture and word slides are followed by interference and recall is measured from short-term (STM) and long-term (LTM) memory. Visual interference has a relatively small effect on recall of visually presented words and pictures as a result of dual storage of stimuli with a pictorial component. Visual interference, they argue, affects only the non-common channel or system (i.e. visual) and not the shared acoustic system. Acoustic interference, on the other hand, causes a decline in recall of both visually presented words and pictures, but words suffer significantly more in recall performance. This difference is due to the fact that pictures are available from the visual store while words are restricted to the acoustic store which has been interfered with.

Can similar evidence for such dual coding be found in children? The findings of Tomlinson-Keasey, Kelly and Burton (1978) indicate progressively increasing left-hemispheric dominance for both words and pictures, in terms of reaction times for words and pictures presented to the hemifields. Seventh graders and particularly adults show a clear left hemisphere dominance for both. Third graders, however, show no hemispheric differences. Since it is necessary for automatic labeling of pictures to take place in order for dual coding to operate, such evidence may suggest that third grade children may not be developmentally ready for dual coding to operate. The present study used the methods of Pellegrino, et.al. with third grade children to

test the applicability of the dual coding hypothesis to this age group.

Can visually presented words be assumed to be "acoustic" in nature? The current investigation included auditorily presented words as stimuli in addition to the pictures and visually presented words used by Pellegrino. Auditorily presented words might reasonably be presumed to be "more acoustic" than visually presented words and should suffer more from subsequent acoustic interference than visually presented words. Visually presented words, even if not stored as visual copies (see Light, Berger & Bardales, 1975) may still be represented with enough visual "imagery" to be more negatively affected than auditorily presented words by visual interference. Pilot work with adults provided data to suggest that this may be the case in adults. The present study contrasted the two presentation modes under differing interference conditions.

Two aspects of a level of processing approach (Craik & Lockhart, 1972) were of interest. The first was the effect of interference tasks on short term versus long term retention of children. Gotz and Jacoby (1974) have shown with adults that when no interference follows a short list, and the participants know that this will be the case, immediate recall is high but subsequent recall is low when compared to groups which had interference tasks following presentation. Similarly, Pellegrino and his associates (1976b) found that within presentation types, those conditions which produce the highest recall in short term memory produce the lowest recall in long term memory. This has been interpreted as the result of processing effort at a deeper level to meet the interference. In the present experiment the degree of recall by interference task was predicted to be reversed from short term to long term memory within presentation types. Thus, for example, acoustic interference, which produces poor short-term performance

with visually presented words relative to visual interference, should produce superior recall in LTM.

Second, general differences in recall were expected as a function of presentation type proposed that such differences may indicate that words and pictures differ in initial level or depth of processing. Pellegrino (Pellegrino, et al., 1976 a, 1976b) has shown that pictures are superior overall in both short term and long term retention, suggestion that words and pictures may in fact differ in level of processing for adults. The present investigation as a partial replication of Pellegrino, et al. (1976a) predicted similar effects on children's recall.

Materials for the experiment were a pool of 75 monosyllabic nouns (e.g., bird, star). Each word has a counterpart picture with a recognizability of 90% or better for first grade students. Visual stimuli were reverse field slides (yellow on black) containing either a line drawing or block print word. Auditory stimuli were recorded by a male adult.

Participants were 30 white third grade students. Following warmup, the experimental task consisted of the presentation of 24 traids of mixed presentation types. The 24 triads represented all the possible combinations o the three types--picture, printed, and spoken--taken three at a time, except that the three single presentation type combinations were eliminated. The combinations were arranged into four blocks of trials such that each block involved the presentation of six stimuli of each type.

Printed word and picture slides were displayed for .5 seco s. An interstimulus interval of 1.0 seconds was used, making the total presentation time for each triad about 3.5 seconds from the opening of the tachistoscopic lens for the first stimulus to the closing for the third.

The interference tasks used for the experiment were similar to those used previously by Pellegrino (Pellegrino, et. al., 1976b). A no interference condition was added. For the visual interference task, Pellegrino's modification of the embedded figures task was presented with the participant instructed to circle the embedded figure. The acoustic interference task involved counting backwards by threes.

In the simultaneous interference task the participants were required to search for an embedded figure and count backwards at the same time. Each interfernece task as well as the no interference condition lasted for ten seconds.

To control for possible confounding of interference task by order all possible orderings of the four interferences tasks were each presented at least once across the 30 participants, with additional ordersings drawn randomly without replacement.

Recall was elicited by instructions from the tape after each traid and interference task. Following all 24 triads, the subject was instructed to free recall as many nouns with presentation types as possible.

The design for both the STM and LTM phases was 3 x 4 univariate ANOVA. Within subject variables were presentation type and type of interfernece. Within this design the dependent measures for both phases were 1) frequency of noun recall and 2) frequency of noun recall with the type of presentation correctly identified.

Table 1 presents the means for frequency of words correctly recalled (f) and frequency of words correctly recalled with the presentation type also correctly identified (f + p). Alpha levels for all tests of significance were set at .01 and Tukey's method employed for post-hoc analysis of significant differences.

In STM, tests for main effects of interference conditions, F (3,87)= 35.97, MSe=1.89, and modality, F (2,58)=8.33, MSe=3.89, were significant for frequency of recall but qualified by a significant interaction (F (6,174)=3.30, MSe=1.21). The acoustic and simultaneous interference tasks produced much lower performance ($\bar{X}$=2.05 and 2.18) than the condition of no interference ($\bar{X}$=3.91). In comparison to the other conditions, however, the visual interference task ($\bar{X}$=3.09) produced only slightly lower recall than the condition of no interference. Post-hoc tests showed that picture recall under acoustic interference was significantly higher than either printed or spoken word recall. Under visual interference conditions, printed words were recalled significantly less often than either pictures or spoken words, while under simultaneous interference only pictures and spoken words differed. This result may be seen clearly in Figure 1.

For correct recall with presentation type correctly identified (f + p) both interference (F(3,87)=34.85, MSe=1.58) and modality (F(2,58)=13.50, MSe=4.25) were again significant but the interaction (F(6,174)=2.25; MSe=1.27; .05 > p > .01) was not.

In LTM the main effect of modality was significant for both frequency of words correctly recalled (F (2,58)=14.91, MSe=.41) and frequency of words recalled with presentation type correctly identified F (2,58)=12.27, MSe=.39. Post-hoc comparisons indicated that pictures were recalled better than spoken words only within the acoustic conditions.

It will be recalled that a general prediction was made, based on the levels of processing approach, that those conditions which produced the highest recall in STM would produce the lowest LTM. Table 3 presents the mean proportions of words recalled in STM and LTM, respectively.

The no-interference condition produced the highest recall in both STM and LTM. Although the remaining three interference conditions did show some tendency to reverse themselves from STM to LTM. (e.g. visual interference which permitted the highest recall in STM produced the lowest recall in LTM for picture and printed stimuli). The differences were not significant. A further exception to the predicted ordering was that spoken words under acoustic interference produce the lowest recall in both STM and LTM.

The present results argue for the applicability of the dual coding hypothesis to young children. In general, recall of pictures was superior under all interference conditions. Although these appears to be no left hemispheric superiority in terms of reaction time to pictures and words at this age level (Tomlinson-Keasey, Kelly, & Burton, 1978), hemispheric specialization may not be as important a factor in the ability to automatically label pictures (a prerequisite for dual coding) is their general language competency. Entering first graders have an average vocabulary of 2,500 words (McCarthy, 1954). Moreover, by seven or eight years of age children already have a linguistic competency (correct use of grammar) equal to that of an adult. Thus, automatic labeling should be well within the capabilities of such children, especially given the level of the nouns involved.

The superior recall of pictures over both printed words and spoken words under conditions of acoustic and simultaneous interference in STM are consistent with the dual coding hypothesis. Single modality interference would affect recall only if memory was coded within that channel and that channel alone. This was generally found to be true. Visual interference produced no differences between the presentation types and only slightly lower performance overall than no interference. Acoustic and simultaneous

interference, on the other hand, did lower recall for printed words and spoken words relative to pictures, interfering with the single channel of coding for printed words and spoken words. Pictures, represented in two channels, were affected to a much lesser extent. The comparison of results under visual and no interference suggest, however, that the acoustic and visual interference tasks were not equal: acoustic appears to have been much more powerful.

While the present results with children are generally consistent with Pellegrino, et. al."s (1975, 1976a, 1976b) findings with adults, the results of adding spoken words require clarification of their view of the printed word as acoustic in nature. The significant interaction of presentation type and interference task in the present STM data is due to the reversal of recall for printed words and spoken words from acoustic interference to visual interference. This would argue that Pellegrino, et al's description of printed words as acoustic may not be complete. Printed words suffer less than spoken words under acoustic interference and more under visual interference, indicating that they are less "acoustic" and more visual than spoken words.

The requirement to recall not only the word by the presentation type did not, in general, produce a pattern different than recall alone. An expectation was that some confusion may have been generated for those stimuli stroed in two systems if one or both channels were interfered with. This was not found to be the case. The fact that children could generally recall the presentation type correctly if they recalled the noun correctly may indicate that not only the information itself is stored (e.g. a picture of a star is stored as an image of a star) and in the verbal system as "picture of a star".

On the basis of Craik and Lockhart's levels of processing approach of Craik and Lockhart (1972) and the findings of Pellegrino et al.(1976b), it was predicted that those interference conditions which maximize performance in STM would minimize it in LTM. A further prediction was that there would be general superiority for recall of pictures in both STM and LTM as a function of deeper processing of the pictorial stimuli. The latter prediction was clearly supported in the present data and is, of course, consistent with the dual coding positions as well. However, the expected reversals from STM to LTM are only minimally suggested in the present data and then only at intermediate levels of interference.

The no interference condition consistently produced the highest recall in both STM and LTM. Gotz and Jacoby (1974) reported that recall after no interference was highest in STM but lowest in LTM when compared to other interference tasks if the participant knew that no interference would follow. They did not find this reversal if the subject knew that no interference would follow. In the current investigation, a set to expect interference is likely to have been present due to the mixed presentation of the interference tasks. Thus, participants may have processed the words at a deeper level than was "necessary," with the effect of improving long term recall for words followed by no interference.

Table 1

Mean Recall in STM

Presentation Type		Interference Task: Acoustic f	Acoustic f+p	Visual f	Visual f+p	Simultaneous f	Simultaneous f+p	None f	None f+p	Total f	Total f+p
Picture	$\bar{X}$	3.10	2.80	3.66	3.36	2.66	2.53	4.23	4.00	3.41	3.17
	SD	1.66	1.66	1.39	1.54	1.56	1.56	1.56	1.61		
Printed	$\bar{X}$	1.76	1.40	2.46	1.83	2.06	1.16	3.86	2.93	2.53	1.83
	SD	1.61	1.61	1.40	1.44	1.38	1.41	1.45	1.63		
Spoken	$\bar{X}$	1.30	1.20	3.16	2.93	1.83	1.46	3.66	3.23	2.48	2.20
	SD	1.26	1.21	1.85	1.81	1.41	1.30	1.53	1.54		
Total		2.05	1.80	3.09	2.70	2.18	1.71	3.91	3.38		

Note. f = frequency correct
f+p = frequency correct with presentation type correct

Table 2

Mean Recall in LTM

Presentation Type		Interference Task: Acoustic f	Acoustic f+p	Visual f	Visual f+p	Simultaneous f	Simultaneous f+p	None f	None f+p	Total f	Total f+p
Picture	$\bar{X}$	0.83	0.80	0.76	0.66	0.86	0.66	0.90	0.80	0.83	0.73
	SD	1.01	0.96	0.97	0.92	1.16	1.12	1.12	0.99		
Printed	$\bar{X}$	0.36	0.33	0.16	0.13	0.33	0.26	0.50	0.46	0.33	0.29
	SD	0.66	0.66	0.37	0.34	0.60	0.52	1.13	1.07		
Spoken	$\bar{X}$	0.13	0.03	0.26	0.23	0.40	0.33	0.46	0.33	0.31	0.23
	SD	0.34	0.18	0.58	0.50	0.62	0.60	0.62	0.47		
Total		0.44	0.38	0.39	0.34	0.53	0.41	0.62	0.53		

Note. f = frequency correct
f+p = frequency correct with presentation type correct

Table 3
Mean Proportion Recalled in STM and LTM

Presentation Type	Recall Type	Interference Task: Acoustic f	Acoustic f+p	Visual f	Visual f+p	Simultaneous f	Simultaneous f+p	None f	None f+p	Total f	Total f+p
Picture	STM	.51	.46	.61	.56	.44	.42	.70	.66	.56	.52
	LTM	.13	.13	.12	.11	.14	.11	.15	.13	.13	.12
Printed	STM	.29	.23	.41	.30	.34	.19	.64	.48	.42	.30
	LTM	.06	.05	.02	.02	.05	.04	.08	.07	.05	.04
Spoken	STM	.21	.20	.52	.48	.30	.24	.61	.53	.41	.36
	LTM	.02	.00	.04	.03	.06	.05	.07	.05	.05	.03
Total	STM	.34	.30	.51	.45	.36	.28	.65	.56		
	LTM	.07	.06	.06	.05	.08	.06	.10	.08		

Note. f - proportion correct
f+p - proportion correct with presentation type correct